TRANSACTIONS
OF THE
ROYAL SOCIETY OF NEW ZEALAND

ZOOLOGY

VOL. 6 NO. 2 FEBRUARY 25, 1965

Egg-care, Eggs and Larvae in the Midget Octopus, *Robsonella australis* (Hoyle)

By ELAINE J. BROUGH,

Portobello Marine Biological Station, University of Otago.

[Received by Editor, 9 June 1964.]

Abstract

THE elongate-ovoid eggs of *Robsonella australis* were laid in strings of 11 to 32 clustered closely on a rock. The female octopus siphoned water on the eggs intermittently. Usually, preceding siphoning, the tentacles were moved through the egg bunches. Other animals that approached were repelled. Both visual and tactile stimuli seemed important in the behaviour. No food was taken during the egg-care period. Hatching began after 81 (±3) days, following which the female died. Eggs, egg bunches and larvae are described. Egg-care behaviour is compared with that of *Octopus maorum* and similarities are noted between the eggs, egg bunches and egg-care of *O. vulgaris*.

A. EGG-CARE BEHAVIOUR

INTRODUCTION

AN opportunity to study the egg-care behaviour of *Robsonella australis* (Hoyle) arose when a specimen laid eggs in the Portobello Aquarium. Benham (1942) has given an account of preserved individuals of this species, including a description of some eggs captured in the same haul as a female specimen. However, no description has been published either of egg-care behaviour or of the larvae of this species.

METHODS AND EQUIPMENT

Some preliminary observations were made in the large concrete tank in the public aquarium in which the eggs were laid, but most were made in a glass-sided tank, 12 x 11 x 7.5 inches, in a laboratory. A continuous flow of sea water was maintained through it, and a stop watch was used to time the various activities of the octopus. The sea water temperature throughout the egg-care period ranged from 18.6°C to 11.5°C. Photographs were made using a "Mecablitz" electronic flash of 1/500 sec duration.

Published by the Royal Society of New Zealand, c/o Victoria University of Wellington, P.O. Box 196, Wellington.

Observations

The female octopus was collected in Otago waters by a local fisherman and brought to the Aquarium on 15 January 1963. Cleaning of the tanks on 25 January revealed two egg masses, one attached to the back of a small rock (Fig. 6) and one on the concrete back wall of the tank directly behind the rock. As no eggs were seen when the tanks were cleaned on 18 January, it is assumed that laying occurred between 18 January and 25 January. A male *Robsonella australis* was also present in the tank at this time. However, it is not known if fertilisation occurred before or after the female octopus came to the Aquarium.

While in the large tank the octopus sat so that some tentacles extended over both egg masses with her body hanging down between the two. When other occupants of the tank (e.g., prawns and camouflage crabs) approached, she extended a tentacle towards them. From this they hastily retreated. On one occasion the male octopus approached but as he did so the female octopus extended her tentacles, left her eggs and appeared to chase him away.

Two weeks after laying, the rock was moved from its original position and placed too far from the eggs on the tank wall for the octopus to attend both batches at once. The number of eggs on this rock decreased substantially, suggesting that they had been eaten by some other animal or animals (Fig. 6 shows original number). When the rock was transferred with the octopus to a small glass-sided tank, in which she could be observed more easily, approximately six bunches of eggs from the concrete tank wall were removed and glued on to two small rocks with Eastman 910 adhesive. These two rocks were then arranged in the tank beside the original rock. Although two of these bunches were dislodged by the tentacle movements and siphoning activity of the octopus, the others remained attached and received her attention.

For more than an hour after the transfer to the small tank, the octopus moved about, pausing only briefly as she passed over the eggs. This movement was accompanied by rapid changes in colour, sometimes with an all-over "blotchy" pattern appearing. She later took up a position so that the three groups of eggs were reached by tentacles which were entwined through and around the individual egg bunches (Fig. 7). These were often held so that they were lifted out from the rocks and hung down over the tentacles or the webbing between them.

Egg-care Behaviour When Relatively Undisturbed

When on the rock in a resting position, the octopus showed a colour pattern that very often matched the colour (orange-brown and brown) of the rock. When the cirri, which are arranged in a definite pattern over the dorsal surface of the body, were elevated the surface texture and apparent outline of the octopus became as irregular as its surroundings. The overall effect was one of successful camouflage.

During several days of the egg-care period, observations of 15 minutes duration were made hourly between 10 a.m. and 6 p.m. At intervals the octopus vigorously siphoned water on to the egg bunches (Fig. 8). The force of water directed at the eggs was strong enough to lift the bunches up off the rocks and even "blew" the tentacles out of position. The siphon, and hence the direction of the water jets, was changed from side to side and usually all egg bunches were moved.

The interval of time between siphonings varied between 5sec and 4min but usually was between 1min 15sec and 1min 30sec. The duration of each siphoning also varied, from 5sec to 45sec; but most were within the range of 10–25sec. (These times were obtained from 30 observations of 15min duration supplemented by numerous shorter observations of 5 to 10min duration.)

There was very little tentacle movement through most of the interval between siphoning activity, but just before each siphoning bout the tentacles were moved through the egg bunches and sometimes tentacle movement continued throughout siphoning. Occasionally, during the non-siphoning interval, one or more tentacles were extended over, around or under the rocks as if the octopus was investigating the possible presence of other animals.

A spectacular aspect of the behaviour was a sudden, extreme "swirling" activity shown several times a day. The octopus swirled the tentacles in very tight coils and passed them over the dorsal surface of the body. This striking action lasted for less than a minute, and was accompanied by strong siphoning. Lane (1957) describes a similar activity in several octopus species and states that it is the mechanism by which the dead surface skin of the suckers is removed. At other times, one or two tentacles were pushed into the mantle cavity and appeared to be swirled inside the gill chamber.

The octopus also siphoned debris away from the floor of the tank beneath the eggs. After several weeks it was noticed that, whereas the remainder of the floor was covered with a thick layer of debris, the tank floor directly beneath the eggs was quite clear.

Throughout the period of egg development the octopus was only once observed to leave the eggs completely. This was after the water jet had accidently been left out of the tank overnight. In the morning, although still breathing, she was very pale in colour. She was hanging limply on to the wall of the tank near the surface of the water. The water flow was resumed at a maximum rate and within three hours the octopus had returned to the eggs and was behaving in the same way as before.

BEHAVIOURAL RESPONSES TO EXTERNAL STIMULI

(a) *Response to visual stimuli.*

It was noticed that the octopus responded to many movements outside the tank but which fell within her visual field. For instance, turning the page of a notebook beside the tank caused her to blush dark orange in colour and "crouch" against the rock. She would remain quite still for about 30sec, but within a minute she returned to her former position and colouration. Putting a finger against the glass side of the tank caused a similar response.

Any quickly-moving shadows caused when a person passed between a window and the tank and other movements, when a person dressed in dark clothing moved against the white background of the laboratory walls, were perceived and provoked the same response of darkening and "crouching". Slow movements about the room did not cause any noticeable response.

When a glass rod (or a finger) was put into the water directly above the octopus, without touching her, she would rise partly off the eggs and extend two or more tentacles upward to the object. This was accompanied by strong siphoning, directed towards the rod, and usually by an immediate darkening in colour.

After three or four weeks in the small tank the octopus did not react so strongly to such stimuli. Wells (1962) remarks on the rapid habituation of *Octopus* in the laboratory. When frequently disturbed she took up a position over the eggs so that the ventral surface of her tentacles and her mouth were exposed and met any approaching object. Her body and the eggs were hidden, and usually only one eye was visible.

(b) *Response to mechanical stimuli.*

The octopus responded to vibrations of the building caused by the slamming of a down stairs door and by heavy footsteps on the outside wooden steps or within the laboratory. The response was a similar darkening and " crouching " such as was caused by the visual stimuli. These disturbances were repeated on various (usually widely separated) occasions and invariably caused the same response.

(c) *Responses to animals introduced into the tank.*

Two large camouflage crabs and two white nudibranchs were introduced together into the tank. At first the reaction was quite spectacular. When one of the nudibranchs crawled on to a rock bearing eggs, tentacles were extended towards it and appeared to push it away. The octopus developed a striking pattern of colouration: a wide cream-coloured stripe appeared on the median dorsal region of the body, standing out against a darker orange-brown colour. The stripe passed over the head between the eyes and across the webbing between the first pair of tentacles. Active siphoning was directed towards the slug and two tentacles remained on it as it moved away. When it was almost out of reach, the octopus rose up, almost off the eggs, and with a single violent siphon jet, " blew " the slug away from the rock. Later reactions to slugs appeared to decrease in intensity. If they approached, their progress was investigated and thwarted by one or two of the octopus's tentacles.

If one of the large crabs approached, the octopus would darken in colour and siphon water at it. If the crab continued to advance, the octopus would leave her eggs and " attack ". She would fling her tentacles over and around the crab and assume a striped or blotchy pattern of colouration (Fig. 9). Promptly the crab scuttled away from her reach. After one experience such as this, the crabs kept away from the vicinity of the octopus and it was difficult to force them to approach her.

If either a slug or a crab was within reach of the octopus, its presence was detected by one or two extended tenacles. It was also noticed that, after these animals were introduced into the tank, the octopus extended her tentacles under and over the three rocks more frequently than before, even though no animals were within sight or reach.

(d) *Response to food.*

All efforts to feed the octopus failed. When a small piece of fish was dropped into the tank, it was taken by the octopus and siphoned away from the vicinity of the eggs. While doing this, the octopus developed a blotchy colour pattern. When small crabs were put into the tank, the octopus paid no attention to them except when they approached her corner. She then siphoned strongly at them. Fish and crabs, given to a male specimen of *R. australis* in a nearby tank, were taken and eaten.

Hatching and Death

The larvae began to hatch on 25 March and hatching continued until 15 or 16 April, by which time virtually all the remaining eggs had hatched. The egg-care period had extended over 81 days. In its later stages, just before and during hatching, the octopus was relatively paler in colour. The intervals between the siphoning bouts and the lengths of individual siphonings remained within the same ranges of time, with the averages also the same as before. On 17 April the octopus climbed out of the tank and was found dead on the bench.

B. DESCRIPTION OF EGG BUNCHES, EGGS AND LARVAE

THE EGG BUNCHES AND THE EGGS

The eggs were grouped into bunches, each of which contained on the average 25 eggs (range 11–35). The bunches that were used as samples had been pulled off the concrete wall of the acquarium tank and it is likely that some eggs were lost in this process.

The eggs were contained in transparent stalked capsules which were elongate-ovoid in shape. Measurements of the length of the egg capsules (excluding the stalk) made by camera lucida drawings, ranged from 2.5 to 2.9mm. The greatest width of the capsules ranged from 1mm to 1.2mm. The length of yolk and developing embryo ranged from 2.0 to 2.5mm.

The stalk, which was continuous with the egg capsule, was barely 1mm in diameter but it was at least 1½ times the length of the egg capsule. Attempts were made to separate entire stalked capsules but, because of the entwining of the many stalks of the bunch and the connecting patches of cement, these were unsuccessful. Thus, accurate measurements of the egg stalk lengths were not obtained. Close to the point where the stalk joins the egg capsule was a slight swelling, more than 1mm in length, but of which the limits were not clearly defined. It caused the appearance of a neck in the stalk where it left the egg capsule but it faded distally into the narrow stalk (Fig. 5). In one preserved specimen which was almost completely separated from the cement, the distal end of the egg stalk could be seen as a rounded expansion.

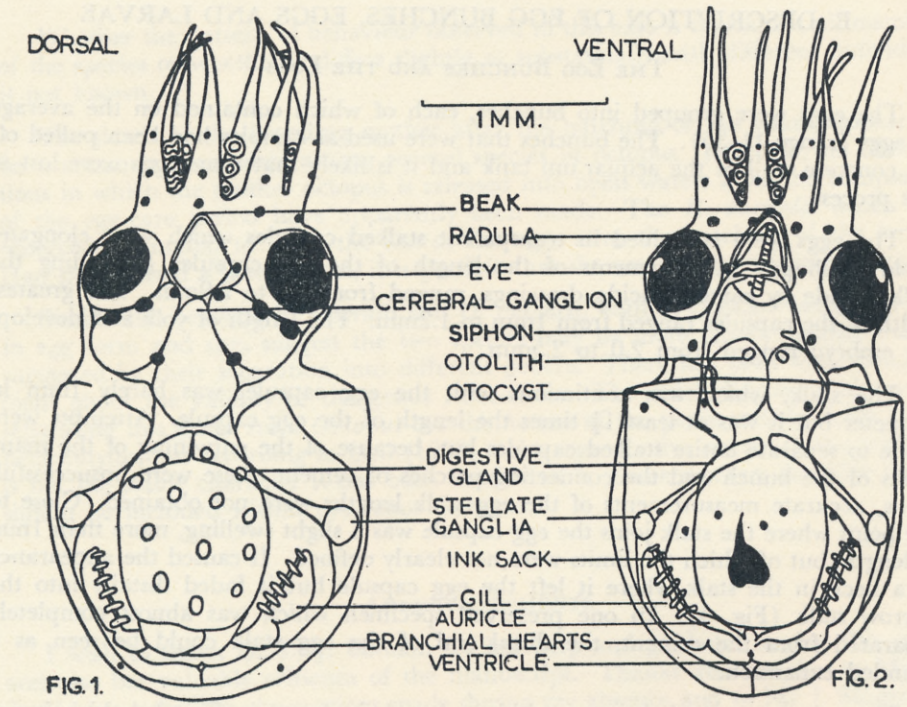
The arrangement of the eggs within a bunch is shown in Fig. 3 (which is not drawn to scale and has been simplified by not showing all the eggs in the bunch). The eggs stalks were entwined about one another and fixed together at several points along the axis of the bunch by patches of cement, which were medium to dark brown in colour. Small dabs of cement fastened the bunch to the rock and to the tank wall. In one or two cases, the axes of two bunches were joined together by cement and the double bunch thus formed was attached to the rock by cementation of the common axis. The total number of eggs laid was estimated at approximately 1,000.

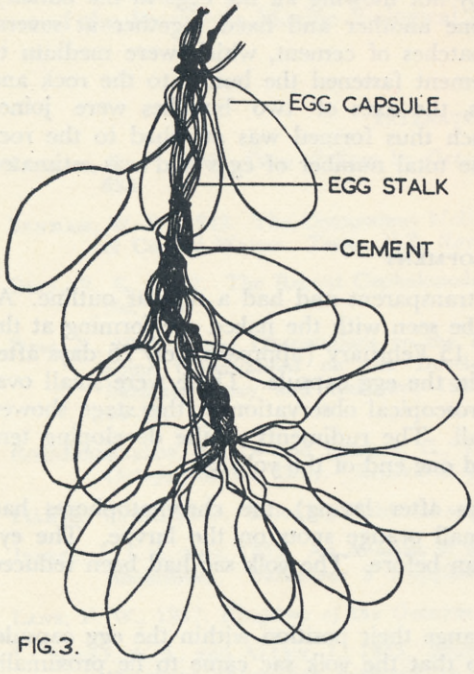
DEVELOPMENT

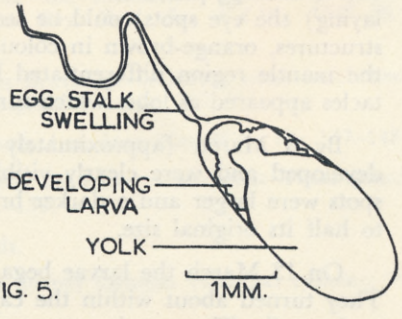
The egg within its capsule was semi-transparent and had a regular outline. As development proceeded, the larva could be seen with the naked eye forming at the end of the egg proximal to the stalk. By 15 February (approximately 25 days after laying) the eye spots could be seen within the egg capsule. These were small oval structures, orange-brown in colour. Microscopical observation at this stage showed the mantle region differentiated but small. The rudiments of the developing tentacles appeared as lobes which surrounded one end of the yolk sac.

By 8 March (approximately 47 days after laying) the chromatophores had developed and were clearly visible as small orange spots on the larvae. The eye spots were larger and a darker brown than before. The yolk sac had been reduced to half its original size.

On 13 March the larvae began to change their position within the egg capsule. They turned about within the capsule so that the yolk sac came to lie proximally to the stalk. The mantle now rested against the rounded end of the capsule with the tentacles pointing towards the stalk. Most of the larvae had turned by 19 March but a few did not change to this position until 28 March.







Figs. 1 and 2.—Dorsal and ventral views of newly hatched larvae showing chromatophore distribution. Those on external body surface black dots, those on dorsal viscera, under mantle, ovals. Internal structures, seen by transparency, are indicated.

Fig. 3.—Arrangement of eggs within a single egg bunch.

Fig. 4.—Inner surface of tentacle of newly hatched larva showing arrangement of suckers.

Fig. 5.—Developing egg with stalk.

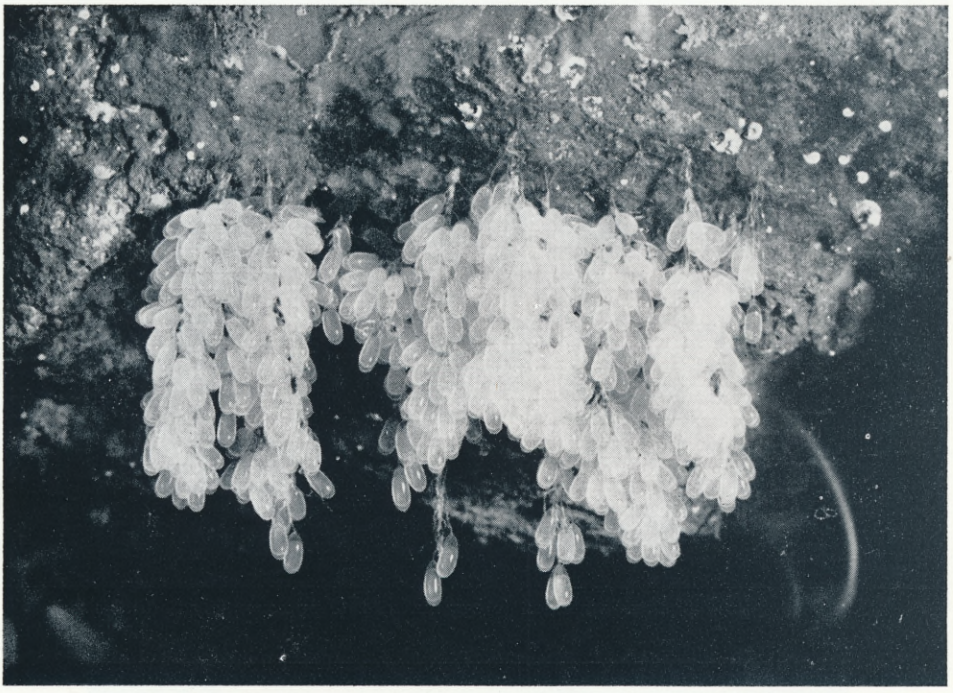


FIG. 6.—Cluster of egg bunches attached to back of rock. (× 2 approx.)

FIG. 7.—Female octopus with eggs: typical position with tentacles entwined around egg bunches. (Approximately natural size.)

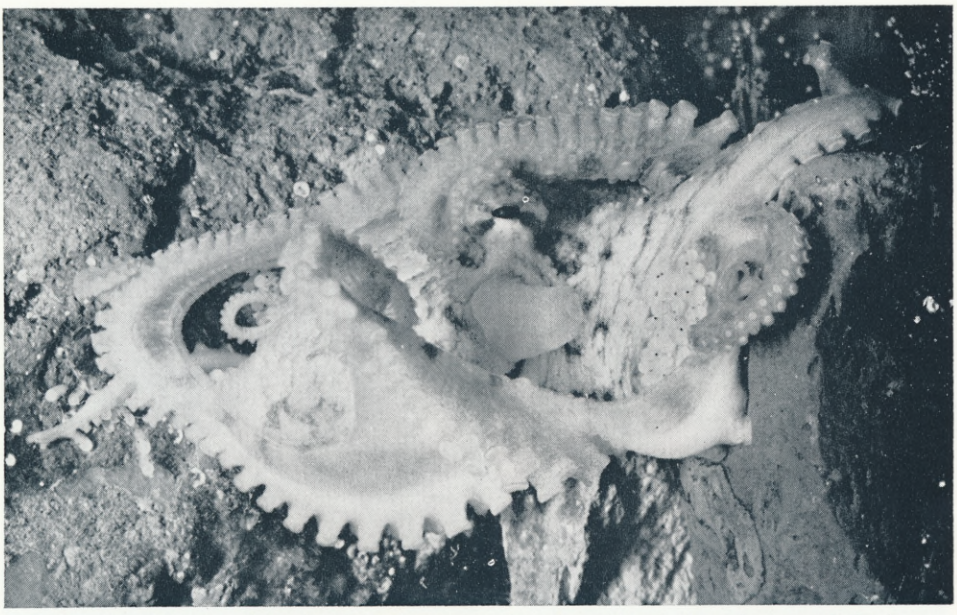


FIG. 8.—Octopus siphoning water on to egg bunches. (Approximately natural size.)

FIG. 9.—Octopus attacking camouflage crab (upper left). Blotchy pattern of colouration shown. (× 2/3 approximately.)

Hatching, which began on 25 March, was very slow, often with individual larvae appearing several hours apart. None were seen in the act of emerging because of the position of the mother. The date on which hatching was completed is not known precisely, but no unhatched eggs remained when the mother died on 17 April.

Upon hatching, the larvae swam with jerky movements, mantle forwards, towards the surface and towards a light source. At first they swam continuously but after some hours they were seen intermittently on the bottom of the tank. Attempts were made to keep them alive both in running sea water and in a bowl of aerated sea water which was changed twice daily. Plankton and brine shrimps were put into the water and although one larva lived for three weeks, none survived longer.

THE NEWLY-HATCHED LARVAE

This description is based on examination of several newly-hatched larvae which were anaesthetized in 7½% $MgCl_2$, and of stained whole mounts and cleared preparations. Over 25 specimens in all were examined.

(a) *Size.*

Seven newly-hatched anaesthetised larva were measured from camera lucida drawings. Overall length measurements were 3.6, 3.7, 3.7, 3.8, 3.9, 3.9, 4.0mm.

(b) *Structural features.*

The tentacles, which were short, relative to the body length, were of approximately equal length. Each had four well-developed suckers arranged linearly along the inner surface. In most cases examined, the sucker nearest the mouth was separated from the one next to it by a small gap, whereas the others were touching or nearly so (Fig. 4). The eyes were large and strongly pigmented.

(c) *Chromatophore distribution.*

The chromatophores varied in size and were all of an orange-brown colour. (This contrasted with the adult condition where, in this species, there were three distinct colour-categories of chromatophores.) Although the number of chromatophores varied from specimen to specimen, the distribution was constant. The typical pattern is shown in Figs. 1 and 2. The arrangement of the chromatophores on the tentacles was identical in all specimens examined. Each tentacle carried three lying in a straight row down the outer surface. The most proximal was the largest and the most distal the smallest.

On the dorsal region of the head the number of chromatophores varied from eight to twelve. In all cases there were two lying immediately anterior to the mantle, overlying the cerebral ganglia. Behind each eye were two large chromatophores while anteriorly, overlying the pharyngeal region between the eyes, there were four to six small ones. In some cases there was also a small chromatophore on the eyelid overlying the pigmented region of the eye.

The only chromatophores on the dorsal mantle were two small ones at the extreme posterior end, lying just behind the branchial hearts. Directly overlying the viscera was a group of chromatophores the number of which varied from twelve to eighteen but was typically thirteen or fourteen. These large chromatophores could be seen through the overlying transparent mantle. Their distribution was rather irregular, with only a general similarity of arrangement from one specimen to another.

On the ventral region of the head was a posterior pair of chromatophores lying half-way between the eyes and the edge of the mantle. More anteriorly, underlying the pharyngeal region, were one or two pairs. On the anterior ventral edge of the siphon there was always at least one small chromatophore. In one case two were seen. On the anterior ventral edge of the mantle there were usually four moderately-sized chromatophores arranged in two pairs, one on each side of the viscera. More posteriorly were a group of which the arrangement was an irregular zig-zag across the mantle and the number of which varied from four to eight. Underlying the heart region, at the posterior end of the mantle, was usually a single small chromatophore.

(d) *Internal structure.*

Much of the internal structure was seen by transparency in the live animal. Within the head, the radula and beak, which did not appear to be strongly developed, were distinguished. The large mass of cerebral ganglia lying behind the eyes occupied most of the posterior head region, overlying the otocysts. The stellate ganglia, heart, and gills, which have six filaments, could be seen within the mantle. The ink sac, underlying the viscera, was prominent.

C. COMPARISON WITH OTHER SPECIES

Several observations of octopus egg-care behaviour have been published, e.g., Fisher (1923), Le Souef and Allen (1933, 1937), Vevers (1961), Eibl-Eibesfeldt and Scheer (1962), but this comparison will be confined to the following two species: *Octopus maorum* Hutton, a specimen of which was brooding eggs in the Aquarium tanks during the summer, and whose egg-care behaviour was observed, and *O. vulgaris* Lmk. of which the behaviour, eggs and egg bunches show certain similarities to those of *R. australis*.

(a) Comparison with *Octopus maorum* Hutton.

The pattern of behaviour shown by the specimen of *O. maorum* observed agrees with the account given by Batham (1957), and some additional observations were made. There was a marked contrast between the behaviour of this animal and that of the *R. australis* female. While the latter showed strong periodic siphoning upon the egg bunches, with only small intermittent tentacle movements, *O. maorum* seldom siphoned on the egg sheet but continuously moved one or two tentacles over and through the eggs. Sea urchins and *Scutus breviculus* were pushed off the egg sheet or prevented from advancing, but strong siphoning was not always directed at them. No spectacular colour changes (such as the "blotchy" pattern of *R. australis*) in response to animals in the tank were shown by *O. maorum*, although the intrusion of a finger into the water above the octopus caused an immediate darkening of colour. As in the case of *R. australis*, tentacles were extended towards any object evidently in an effort to repel it. Movements and shadows passing in front of the glass tank caused no response in *O. maorum* as they did in *R. australis*.

Since both *O. maorum* and *R. australis* are common inshore octopuses of the Otago coast, tables have been made to compare the newly-hatched larvae (Table I) and the eggs (Table II). Figures cited for *O. maorum* are taken from Batham (1957).

(b) Comparison with *Octopus vulgaris* Lmk.

O. vulgaris, although a much larger species than *R. australis,* appears to show some similar behavioural features. *O. vulgaris* siphons water on to eggs at varying intervals of time. These siphonings are followed by periods of rest, during which there is tentacle movement through the eggs (Vevers 1961). This siphoning activity was shown by *R. australis* although it was not observed to increase in vigour in the later stages of the egg-care period as Vevers reports for *O. vulgaris.*

The eggs of *O. vulgaris* are laid in bunches containing 200 to 400 eggs, which like those of *R. australis,* have the egg stalks entwined and cemented together. The eggs are small, similar in size to those of *R. australis.* The length of the egg capsule varies from 1.9 to 2.2mm (c.f. *R. australis,* 2.4 to 2.8mm). The stalk when separated, is approximately twice as long as the egg capsule. The longest one separated for *R. australis* was $1\frac{1}{2}$ times the length of the egg capsule.

Pickford (1950) describes in *O. vulgaris* a small swelling on the egg stalk proximal to the egg capsule, which she says is "almost like a float". Although *R. australis* eggs also have a noticeable swelling in this region of the stalk, no clearly definable perimeter to the bulge could be seen within the stalk. The one egg stalk of *R. australis* eggs that was partially separated shows an expanded end similar to that figured by Pickford.

D. DISCUSSION

Few marine invertebrate animals care for their eggs, but this appears to have become prominent among octopuses. The protection given by the mother appears to increase the number of eggs surviving. Removal of the eggs from the care of the octopus during the early stages of development resulted in a large number being lost, presumably largely through predation by other animals.

The adaptive significance of siphoning water on to the eggs is not known, nor is the movement of tentacles through the eggs. It may be to remove debris, to circulate water throughout the bunches and so to aerate them, or a combination of the two. Van Iersal (1953), working with the three-spined stickleback, found a correlation between the strength of activity of the male and the oxygen consumption of the eggs. A similar correlation may exist in the case of the octopus, although no change in the duration of the siphoning was observed during the development of the larvae. However, the statistical significance of the observations was not assessed. A relationship between increased oxygen consumption with further development of the larvae and a change in the speed and amount of water circulated could exist. Experiments in which the CO_2 or O_2 concentration of the water was altered would perhaps give interesting results.

Another point of interest is the development of the egg-care behaviour pattern. It has been noticed that other female specimens of *R. australis,* when at rest, sometimes show bursts of siphoning activity which last approximately the same length of time as those of the brooding octopus. The bursts are, however, very infrequent and show none of the periodicity of those of the octopus with eggs. Perhaps the egg-care pattern is just an augmented pattern of behaviour that occurs without eggs.

The egg-care behaviour pattern appears to be strongly developed. When the rock bearing the eggs was moved, the octopus clung to the rock even when it was taken out of the water. After the water flow into the tank was accidently removed for approximately fourteen hours, the octopus took three hours to return to the eggs. The reversion to egg-care after a period of near death may also be indicative of the strength of this element of behaviour.

TABLE I

Comparison of the Newly Hatched Larvae of *Octopus maorum* and *Robsonella australis*

	Overall length	Number of suckers on each tentacle	Chromatophore Distribution						
			Number on tentacles	Dorsal Head	Dorsal mantle (Anterior region)	Posterior mantle (part dorsal part ventral)	Dorsal viscera	Ventral head	Ventral mantle
Octopus maorum	6.7 to 7.6mm	7 to 8 in irregular zig-zag arrangement	8 to 11 in a straight or wavy row	20 to 22	2 to 7	24 to 32	47 to 53	2 to 3	9 to 16 + 2 on siphon
Robsonella australis	3.6 to 4.0mm	4 in a straight row	3 in a straight row	8 to 12	—	3	12 to 18	4 to 6	8 to 12 + 1 on siphon

TABLE II

Comparison of the Eggs of *Octopus maorum* and *Robsonella australis*

	Length of capsule plus stalk	Width of egg capsule	Length of egg in capsule	Shape	Arrangement in egg bunches
Octopus maorum	9.8 to 11.8mm	1.4 to 1.8mm	4.0 to 6.0mm	elongate pyriform	3 to 10 eggs with stalks attached directly to substratum.
Robsonella australis	Approximately 6.2 to 7.2mm	1.0 to 1.2mm	2.0 to 2.5mm	elongate ovoid	11 to 35 eggs arranged in bunches with stalks entwined and fastened together by patches of cement. Whole bunch attached to substratum at one end of main axis.

Whether the pattern of behaviour observed in this case is typical for all members of the species or whether it differs slightly or substantially with different individuals is not known.

The death of the brooding mother after the hatching of the young appears to be a common occurrence among several species of octopus. However, no observations in which the mother octopus is released into open waters after the completion of the egg-care period have apparently been made. The *R. australis* which was observed attempted to leave the site of the eggs after the hatching of the larvae. Had she reached a new habitat, it is possible that she may have remained living.

Similarities between *R. australis* and *O. vulgaris,* both in egg-care behaviour and in egg form and size, suggest the two species may be more closely related than is suggested by their separation into different genera. There has been some disagreement about the validity of the genus *Robsonella.* The chief diagnostic characters separating this genus from *Octopus* are the nature of the penis and the form of the hectocotylus, but according to Dell (1952) " the reproductive system in the octopods is not the stable character it has been considered ". Some workers consider that it should be included within the genus *Octopus.*

Acknowledgments

I wish to thank Dr E. J. Batham for her help and guidance during this study, and also her valuable criticism of the manuscript. Thanks also are due to Miss S. Austin for recording observations made during my absence and to Mr J. Stuart and Mr T. Gordon for the preparation of photographs. I also wish to acknowledge the use of the Portobello Marine Biological Station laboratories and equipment.

Literature Cited

Batham, E. J., 1957. Care of Eggs by *Octopus maorum. Trans. Roy. Soc. N.Z.,* 84: 629–638.

Benham, W. B., 1942. The Octopodous Mollusca of New Zealand. (1) The Midget Octopus of Coastal Waters. *Trans. N.Z. Roy. Soc.,* 72: 226–236.

Dell, R. K., 1952. The Recent Cephalopoda of New Zealand. *Dominion Museum Bulletin* No. 16.

Dew, B., 1959. Some Observations on the Development of Two Australian Octopuses and Some Observations on the Development of the Australian Squid *Sepioloidea lineolata* Quoy and Gaimard, 1832. *Proc. Roy. Zool. Soc N.S.W.,* 1957–58: 44–55.

Eibl-Eibesfeldt, I. van and Scheer, G., 1962. Das Brutpflegever halten eines weiblichen *Octopus aegina* Gray. *Zeitschrift für Tierpsychologie,* 19: 257–261.

Fisher, W. K., 1923. Brooding Habits of a Cephalopod. *Ann. Mag. Nat. Hist.,* 12: 147–149.

Iersel, J. J. A. van, 1953. An Analysis of the Parental Behaviour of the Male Three-spined Stickleback. *Behaviour* 3 (supplement): 1–159.

Lane, F. W., 1957. *Kingdom of the Octopus.* Jarrolds.

Le Souef, A. S., and Allen, J., 1933. Habits of the Sydney Octopus (*Octopus cyaneus*) in Captivity. *Australian Zoologist,* 7: 273–376.

———— 1937. Breeding Habits of a Female Octopus. *Australian Zoologist,* 9: 64–67.

Messenger, J. B., 1963. Behaviour of Young *Octopus brianeus* Robson. *Nature,* 197: 1186–1187.

PICKFORD, G. E., 1950. A Note on the Eggs of *Octopus vulgaris* Lam. from the Western Atlantic. The Identity of Tandy's Eggs from the Dry Tortugas. *Proc. Malac. Soc. Lond.*, 28: Pts. 2 and 3: 88–92.

VEVERS, H. G., 1961. Observations on the Laying and Hatching of Octopus Eggs in the Society's Aquarium. *Proc. Zool. Soc. Lond.*, 137: 311–315.

WELLS, M. J., 1962. *Brain and Behaviour in Cephalopods.* Heinemann, London.

YOUNG, J. Z., 1962. Courtship and Mating by a Coral Reef Octopus, *O. horridus. Proc. Zool. Soc. Lond.*, 138: 157–162.

ELAINE J. BROUGH, B.Sc.(Hons.),
Department of Zoology and Comparative Physiology,
Monash University,
Clayton,
Victoria, Australia.